CERC Technical Report No. 10

The Elephant Hills

Conservation of Wild Asian Elephants in a Landscape of Fragmented Rainforests and Plantations in the Anamalais, India

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nature
conservation
foundation

Citation

KUMAR, M. A., MUDAPPA, D., RAMAN, T. R. S. & MADHUSUDAN, M. D. 2004. The elephant hills: Conservation of wild Asian elephants in a landscape of fragmented rainforests and plantations in the Anamalais, India. CERC Technical Report No. 10, Nature Conservation Foundation, Mysore.

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Cover photograph

A herd of elephants heads through a tea estate into a patch of riverine secondary forest vegetation along the Sholayar river, an important habitat and movement corridor for elephants in the fragmented landscape of the Valparai plateau.

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Acknowledgements

We thank the United States Fish and Wildlife Service for financial support and Dr A. Christy Williams and the Elephant Sanctuary, Hohenwald, Tennessee, for additional support for this project. Dr Karl A. K. Stromayer and Mr Fred Bagley of the USFWS provided much help and encouragement during the project for which we are grateful.

The Tamil Nadu Forest Department, particularly the Chief Wildlife Warden Dr Sukh Dev, and the Wildlife Warden of the Indira Gandhi Wildlife Sanctuary, Mr V. Ganesan, provided permits and encouragement for the work. The Range Officers (Mr T. Panneerselvam, Mr G. Sivamani, Mr A. Murthy) and various other forest staff provided local support for the research team—we are grateful for their help.

The Anamallai Biodiversity Conservation Association supported us in the work on private lands and a number of plantation company managers generously provided us with help and support for which we are grateful: Mr D. G. Hegde, Mr J. T. Kamdin, Mr Simon Vasnaik, Mr Arjun Sanadi, and a long list of other people not possible to include here.

We are grateful to Drs Ajith Kumar, Mewa Singh, A. J. T. Johnsingh, R. Sukumar, A. Venkatraman, and Cheryl Nath for helpful discussions and suggestions. Mr Theodore Baskaran was helpful in communicating the results of the project to local press people and Mr S. U. Saravanakumar helped with photographic documentation.

We derived great inspiration and support from our colleagues at NCF: Charudutt Mishra who gave us direction and purpose with ruthless efficiency, Aparajita Datta for her enthusiasm, interest, and encouragement, Pavithra Sankaran for her fire-brand approach to building awareness for elephant conservation in this region, P. Suresha for single-handedly taking impeccable care of all finances and accounting, and R. Raghunath, Hari Sridhar, and Vena Kapoor for their help in data collection and compilation.

Finally, we are grateful to our assistants A. Silamban, G. Murthy, T. Dinesh, A. Kumar, and A. Satish for assistance in the field.

Executive summary

BACKGROUND AND AIMS: *The Valparai plateau abutting the Indira Gandhi Wildlife Sanctuary is a 220 km² landscape mosaic of plantations (mainly tea), rainforest fragments, and a lattice of streams and rivers. The presence of forest fragments and surrounding protected areas makes this region home to a wide range of rainforest plants and animals, including the charismatic and endangered Asian elephant. In Valparai, as in most other places where man and elephant overlap in their need for resource and space, there is conflict. During this one-year study, we aimed to assess the importance of remnant forests for movement of elephants, habitat use, and the nature and magnitude of conflicts in order to find measures to minimise incidence and prevent intensification of conflicts, and promote coexistence between people and elephants in this fragmented landscape.*

METHODS: *Elephant movements and habitat use were documented through direct tracking of herds that entered the plateau (14 herds, 162 individuals) between April 2002 and March 2003. We estimated losses through field visits to conflict sites and interactions with plantation workers and officials. To assess elephant use of rainforest fragments, encounter rates of elephant dung were estimated from 11 belt transects totalling a sampling effort of 96.8 km across 9 fragments (10 – 2600 ha) sampled between January and June 2002. Elephant distribution on the landscape mosaic of the plateau and elephant use of 10 main habitats was assessed through road surveys (seven routes, total effort = 230.85 km) for dung. Workshops and discussion meetings were organised to increase awareness, disseminate findings, and introduce measures to minimise conflict.*

OBSERVATIONS AND FINDINGS:

- *Asian elephants have used the Valparai plateau historically and will continue to use this region during their seasonal movements. This is because of the: (a) terrain, which is gently undulating on the plateau with rugged mountains all around, and (b) landscape, which is an enclave of plantations surrounded by the Anamalai-Parambikulam Elephant Reserve.*

- *During the study, three herds used this landscape frequently and almost the entire plateau fell within their ranges. Many peripheral herds were also recorded close to the protected area boundaries.*

- *Only two adult males were seen during the study period, indicating a highly skewed adult sex ratio (c. 1 male:38 females), which is a matter of serious conservation concern.*

- *On an average, the Valparai plateau contains about 1-2 elephants/1000 ha as against 4500 people/1000 ha!*

- *At least one herd used the plateau at any given time, although up to three herds (41 elephants) were seen occasionally. Contrary to common belief, elephants were not present in all the estates all the time!*

- *A major route of elephant movement (between protected areas) was found across the Valparai plateau, with elephants frequently using fragments and riverine vegetation along Sholayar and Nadu Ar.*

- *Elephants preferentially used natural vegetation (rainforest fragments, secondary, and stream vegetation), plantation-natural vegetation edges, and* Eucalyptus *plantations as daytime refuges that provided cover and forage on movements across the landscape.*

- *Elephants moved through tea plantations mostly at night, and avoided the proximity of human settlements.*

- *Fragments containing* Ochlandra *bamboo appeared to have greater elephant use and lower incidence of conflict in the immediate surrounding landscape.*

- *Conflict incidents mainly comprised damage to buildings and raiding of grain stored therein (especially in school noon-meal centres and stores). Damage occurred mostly at night and mixed herds (males, females and young) were invariably responsible for it.*

- *The 157 conflict incidents recorded over the one-year study period resulted in one human death, one elephant death, and a monetary loss of about Rs. 758,116. Annual monetary loss is about Rs. 35/- per hectare of plantations, a negligible amount to most large companies.*

- *Estates towards the centre of the Valparai plateau faced higher monetary losses, although estates adjoining the boundary of reserved forests, National Parks and Wildlife Sanctuaries were more frequently visited by elephants.*

- *Elephant movement and activity was highest during the period between November and February. Highest losses and incidents were also recorded during this period.*

- *This seasonal pattern of elephant movement and conflict intensity seems to be consistent with historical records, which indicates more human deaths due to elephants during this period.*

- *On average (1994-2003), there were around 3 human deaths a year due to elephants on the plateau. However, these have mostly occurred within the plantations and not in tribal settlements within the Indira Gandhi Wildlife Sanctuary. This therefore indicates the necessity to increase awareness among people and help in establishing attitudes and life-styles that promote coexistence with endangered species such as Asian elephants.*

CONCLUSIONS: *The protection of remnant forest vegetation in such plantation-dominated landscapes will serve as refuges for elephants (and other wildlife) and stepping stones on movement corridors. Conservation of rainforest fragments may help funnel elephant movement and reduce conflict in the surrounding landscape. Further strategies for elephant conservation in the region include: a) restoration of riverine vegetation and of select degraded sites with bamboo, b) regulations for selective felling of* Eucalyptus *fuel-wood plantations, c) prevention of further conversion to tea plantations and creation of obstacles to elephant movement, and d) protection of the highlighted elephant movement routes. Better communication within and between companies, barricades/fences to secure vulnerable sites (buildings and labour colonies) without disrupting elephant movement routes through estates, and conservation awareness programmes for students and local people can help promote human-elephant coexistence in this region.*

1. Project Background

INTRODUCTION

The Anamalai, a hill range in southern Western Ghats named after the Asian elephant *Elephas maximus*, contains the second largest population of this endangered species in India. This area has also been identified as one of the areas with the greatest potential for the long-term conservation of Asian elephants despite its high human population density (Leimgruber *et al.* 2003). Within this region lies the Valparai plateau, extending over 220 km², densely settled by about 100,000 people, and spread over a landscape of tea, coffee, and *Eucalyptus* plantations owned by about 50 private estates and companies. The Valparai plateau, once containing a large tract of tropical rainforest now only has remnant forest fragments that form critical wildlife habitat within the matrix of plantations.

Today, two critical issues dominate Asian elephant conservation in this region. First, there is a serious lack of data on elephant population structure and dynamics, habitat use, and movement patterns which hampers conservation efforts in the region. Second, there is intense and growing conflict between elephants and people as herds of elephants move through private land damaging property, destroying crops, and killing people. Very little is known about the extent and causes of conflict that would help identify measures to reduce it.

OBJECTIVES OF THE PROJECT

Against this background, we initiated a project to:

1. Study correlates of Asian elephant use of rainforest remnants, plantations, and other habitats in the landscape matrix of the Valparai plateau;

2. Identify elephant movement routes in relation to land-use and landscape features;

3. Assess the spatial and temporal distribution of conflict incidents, identify their potential causes and formulate strategies for its management;

4. Disseminate findings of the study to private landowners, companies, and the Forest Department to evolve strategies for minimising conflict and effecting conservation of elephants.

WHAT THIS REPORT CONTAINS

In **Chapter 2**, we describe the study area in some detail. **Chapter 3** describes elephant use of rainforest fragments and plantation habitats on the Valparai plateau. **Chapter 4** pertains to identification of elephant movement routes using data on herds tracked through the major habitats on the Valparai plateau. **Chapter 5** presents observations on spatial and temporal patterns of human-elephant conflict in this landscape. Finally, in **Chapter 6** we identify potential conflict resolution measures and report on the ongoing implementation of recommendations emerging from the study.

2. Study area

THE WESTERN GHATS

The Western Ghats is a 1,600 km long chain of hills running along the west coast of the Indian Peninsula (8° N - 21° N). The chain of hills is interrupted by the 30 km wide Palghat Gap at around 11° N, and a few other minor gaps along its length (Figure 2.1). This unique biogeographic province (Mani 1974, Rodgers and Panwar 1988) has pronounced north-south, east-west, and elevational gradients, which have profound consequences for the distribution of plants and animals. The southern end of the Ghats has a short dry season (2 – 5 months) and the northern reaches. The average annual rainfall ranges between <1000 mm – 7500 mm depending on the locality, aspect, and latitude (Pascal 1988, Daniels 1992).

Most of the higher hills (1,000 – 2,000 m), and moist forests including the tropical wet evergreen forests in the Western Ghats are found towards the south, between 8° N and 13° N, a region often called the southern Western Ghats. This is also the region that contains higher diversity and a greater number of endemics of rainforest plant and animal taxa (Nair and Daniel 1986, Daniels 1992), and also the region which supports a major proportion of the south Indian elephant population (Leimgruber *et al.* 2003).

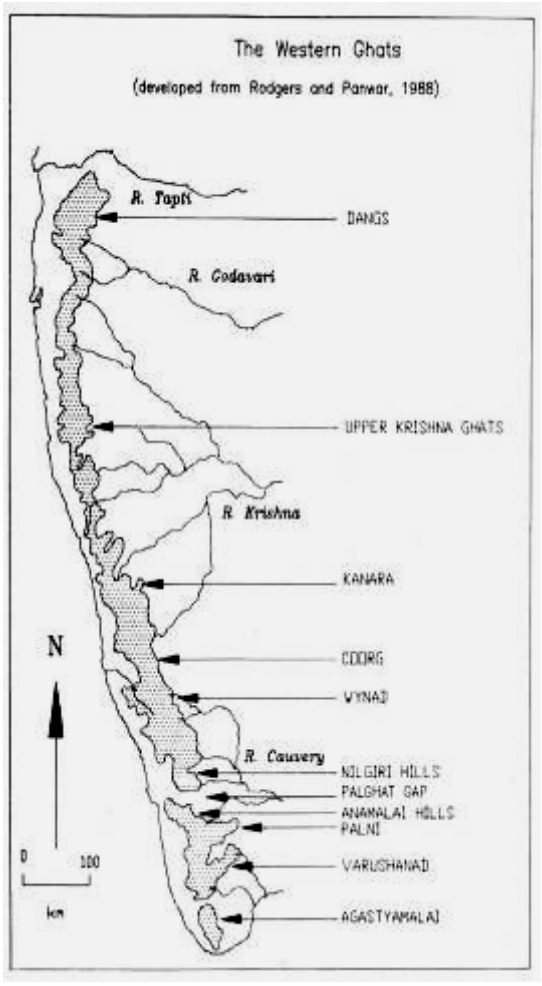


Figure 2.1: Map of the Western Ghats showing hill ranges and the Anamalai hills south of the Palghat gap.

THE ANAMALAI HILLS

The Anamalai (Tamil: elephant hill) range is one of the most important conservation areas for wild Asian elephants containing the second largest population in India (Sukumar 1989, 2003). The Anamalai-Parambikulam

Elephant Reserve in the southern Western Ghats is one of the eleven elephant reserves in India containing an estimated population of about 1,600 elephants (6% of the total 25,000) in an area of approximately 5,700 km² (Desai 2000).

This study was carried out in the private lands of the Valparai plateau of Anamalai hills. This plateau is surrounded by protected areas on all sides: Eravikulam National Park, Chinnar Wildlife Sanctuary, Vazhachal Reserve Forest, and Parambikulam Wildlife Sanctuary in the adjoining Kerala state, and the Indira Gandhi Wildlife Sanctuary and Grass Hills National Park in Tamil Nadu (Figure 2.1). Prior to 1890, the nearly 220 km² of the Valparai plateau contained a large unbroken expanse of tropical wet evergreen forest. Writing about the landscape at the time, early British explorers noted, "*There were miles and miles of evergreen forest, with a few main paths running through it made by the huge herds of elephants which roamed there …*" (Congreve 1942). During the last century, this region, converted to plantations of tea, coffee, *Eucalyptus*, and cardamom, also saw the development of roads, infrastructure, and reservoirs, and is now a densely populated area with around 100,000 people in the Valparai town and surrounding estates (Figure 2.2). These activities have only left around 25 remnant rainforest patches ranging in size from 1-2600 ha.

The surrounding protected areas contain large areas of tropical dry and moist deciduous forests, high-altitude shola-grassland ecosystems, and mid-elevation tropical wet evergreen forest (of particular interest to this study). The natural vegetation of this region, receiving over 2,500 mm of rainfall annually, particularly during the southwest monsoon (June – September), has been classified as mid-elevation tropical wet evergreen forest of the *Cullenia exarillata-Mesua ferrea-Palaquium ellipticum* type (Pascal 1988). Although a significant portion of the tropical evergreen forest occurs within the Indira Gandhi Wildlife Sanctuary (958 km², 10° 12' N to 10° 35' N and 76° 49' E to 77° 24' E), many of the smaller (< 200 ha) rainforest fragments occur in private lands in the Valparai plateau (Figure 2.2). Most small fragments are highly disturbed due to chronic fuel-wood collection, livestock grazing, past conversion, and hunting. The plateau is frequently used by wide ranging large mammals including elephants (Kumar *et al.* 2002).

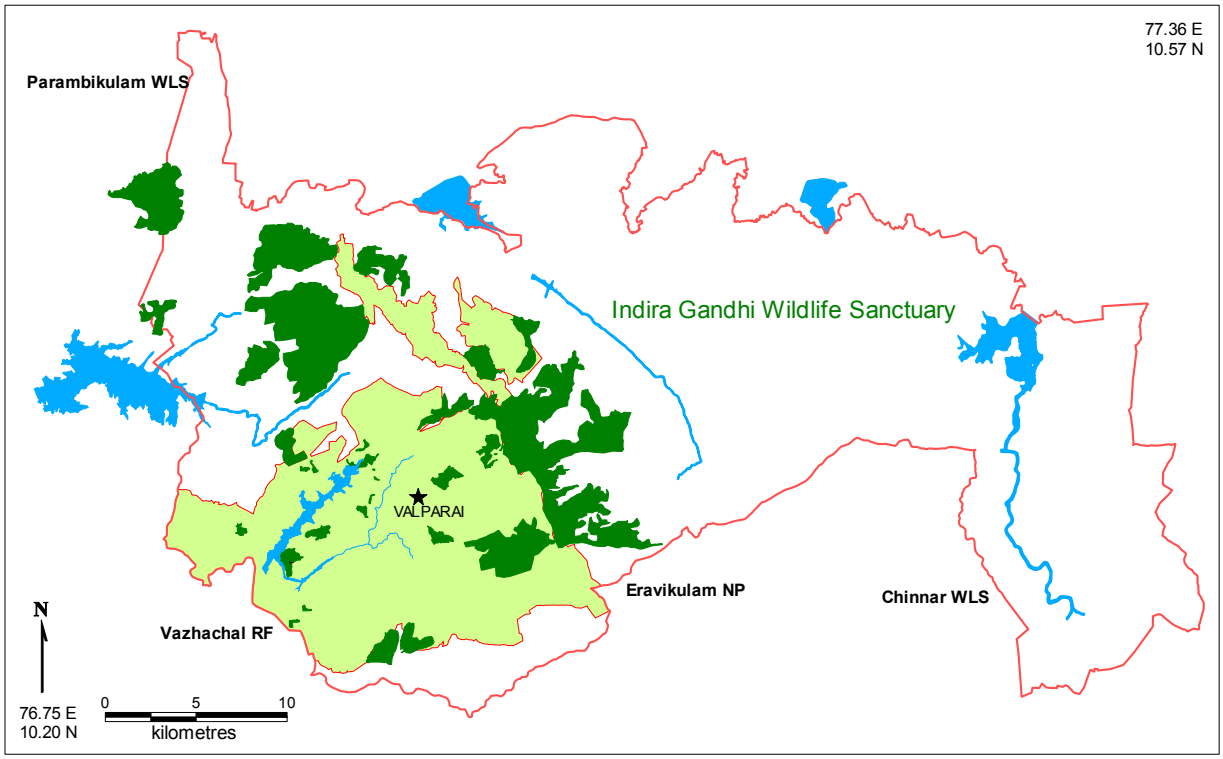


Figure 2.2: Map of the study area showing private plantations on the Valparai plateau (light green), rainforest fragments (dark green), reservoirs and major riverine areas (blue), and the surrounding protected areas.

3. Asian elephant use of rainforest fragments and the surrounding matrix of plantation habitats

INTRODUCTION

The close juxtaposition of human habitation and elephant habitats is a leading cause of conflict in regions such as Peninsular Malaysia (Blair *et al.* 1979), Africa (Thouless 1994, Hoare 1999), and India (Sukumar 1990, Williams and Johnsingh 1996, Nath and Sukumar 1998, Williams *et al.* 2001), which are also among the last strongholds of elephants on earth. Investigating spatial relationships between landscape configurations of human settlements, habitat remnants, and elephant activity is an important area of research that will aid in understanding and resolving human-elephant conflict (Hoare 1999). It is critical to understand the role that habitat remnants play in determining patterns of landscape use by elephants as well as incidence of conflict in a fragmented landscape mosaic. It is possible that the likelihood of conflict may increase due to the presence of remnants and their high interspersion with human habitation and cultivation (Nyhus *et al.* 2000, Singh *et al.* 2002). On the other hand, habitat remnants distributed in an inhospitable matrix may function as corridors facilitating the feeding and movement of elephants, and their retention may reduce or prevent escalation of conflict (Desai 1991, Sitati *et al.* 2003). It is in this context that it is necessary to examine the role of rainforest fragments that remain on the Valparai plateau. Here, we examine use of tropical rainforest fragments, degraded forest, and plantation habitats by wild Asian elephants (*Elephas maximus*) in this landscape mosaic and discuss implications of emerging results for the conservation and management of Asian elephants in this region.

OBJECTIVES

The main objectives of this part of the study were to:

1) Assess the elephant use of rainforest fragments and the landscape mosaic of plantations, and

2) Identify the habitat and landscape correlates influencing elephant use and incidence of conflict in the Valparai plateau.

METHODS

Dung pile encounter was used as an index of abundance or intensity of use by elephants of nine rainforest fragments in private plantations and in the Indira Gandhi Wildlife Sanctuary and the various vegetation types in the landscape (Merz 1986, Williams and Johnsingh 1996), as elephants were difficult to sight in the dense vegetation. This part of the study was conducted between December 2002 and June 2003 and used two main methods: fragment surveys and road surveys.

FRAGMENT SURVEYS

Elephant use of rainforest fragments was assessed using strip transects. These fragments were distributed across the Valparai plateau and ranged in size from 10 ha to 2600 ha (Table 3.1). Eleven strip transects of 0.748 to 3.30 km length, varying according to fragment size, totalling 19.4 km were marked, with three transects in the largest fragment (Table 3.1). Due to the rugged terrain and to minimize disturbance to vegetation, we walked along existing trails through the forest to ensure maximum area coverage. We scanned the area up to 2 m on either side of each transect to count dung piles and boluses that were less than 1 month old. Any set of two or more boluses that were more than 2 m from other such sets were counted as separate dung piles. Each transect was monitored 5 times at monthly intervals between January and June 2003.

Table 3.1: Fragments surveyed for elephant dung, including sampling effort in private plantations on the Valparai plateau and in the Indira Gandhi Wildlife Sanctuary (IGWLS) in the Anamalai hills.

S. No.	Fragment	Area (ha)	Matrix*	Line length (km)	Ownership
1.	Akkamalai complex			1.625	IGWLS
2.	- do -	2600	T, E, DF	2.050	IGWLS
3.	- do -			1.462	IGWLS
4.	Andiparai	200	T, E	2.312	IGWLS
5.	Injipara	18	T, E	1.902	Private
6.	Kalyanapandal	22	T	0.748	Private
7.	Manamboli	200	T, E, DF	3.300	IGWLS
8.	Pannimade	88	T, R	1.224	Private
9.	Puthuthottam	92	T, C, E	2.227	Private
10.	Sangli Road	10	T, E	1.326	Private
11.	Tata Finlay	33	T, C, E	1.190	Private

* T = tea, C = coffee, E = *Eucalyptus*, DF = deciduous forest, R = reservoir

MAPPING AND HABITAT CHARACTERIZATION

Fragment area was determined by walking around fragments with a Geographical Positioning System (GPS, Garmin 12XL or 12 CX) handset. The largest fragments were mapped using a combination of field surveys, satellite imagery, and 1:50,000 Survey of India topographical maps and digitized using the program, MapInfo. Nine landscape variables of each fragment such as area, mean altitude, altitudinal range, distance to park/reserve boundary, edge-to-edge and centre-to-centre distances to the nearest fragment, and composition of the surrounding matrix were measured. We also measured eleven site and habitat variables such as tree density, canopy cover, basal area, shrub density, noted presence-absence of livestock grazing, bamboo, cane (*Calamus sp.*), and lianas, and scored degree of disturbance for each site, using standard vegetation sampling techniques (Kent and Coker 1992). The influence of these landscape and site variables on elephant dung encounter rates was explored using standard nonparametric correlations and tests of association (Siegel and Castellan 1988).

ROAD SURVEYS

The Valparai plateau has a good network of roads, which were used to survey the landscape mosaic across the plateau and to assess elephant use of the different habitats. Seven road surveys were carried out covering a distance of 231 kilometers through the landscape habitat mosaic. Along each road survey route, we measured the length of route passing through each of seven major habitat types: tea plantation, coffee plantation, plantation edge (any two different monoculture habitats on either side of the road), natural vegetation (rainforest fragments, degraded rainforest with secondary vegetation), natural vegetation edge (monoculture habitat and natural vegetation on either side of the road), and other habitats (including *Eucalyptus* plantation, swamps, and streams). Besides the major roads, we also obtained a wide, representative coverage of the plateau by surveying numerous minor roads and estate roads with low traffic (Figure 3.1). The vehicle odometer was used to measure distance traversed (to the nearest 0.1 km) in the different habitats. For each encounter of elephant dung we noted the number of dung piles that were less than one month old, type of habitat on either side of the road, exact location with a GPS. We compared observed frequencies of encounter of

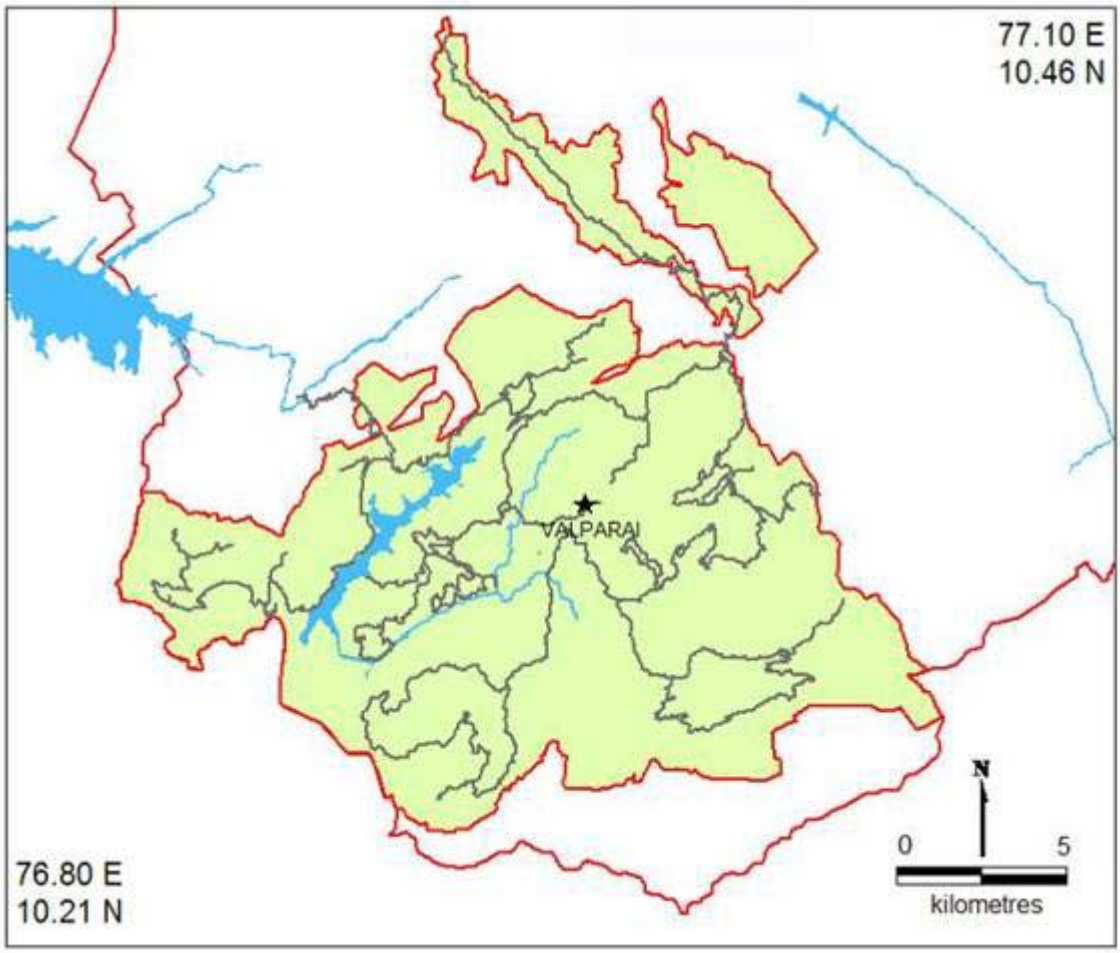


Figure 3.1. Road survey routes covered on the Valparai plateau, Anamalai hills, to examine distribution of elephants in the landscape mosaic of plantations.

elephant dung piles in each of the seven habitat types with expectation based on the proportion of route length in each habitat. We compared observed and expected use of elephants of the seven major habitat types using chi-square goodness-of-fit tests (Zar 1999).

RESULTS

ELEPHANT ABUNDANCE IN RAINFOREST FRAGMENTS

In total, we encountered 162 dung piles in the nine fragments in 96.8 km of transects over the duration of the study. Elephant dung pile encounter rate ranged from 0/km in the Puthuthottam fragment in the heart of the Valparai plateau near Valparai town to 10.7/km in the Kalyanapandal fragment close to the sanctuary boundary (Table 3.2).

Table 3.2: Encounter rates of elephant dung per kilometer in different rainforest fragments on the Valparai plateau, Anamalai hills, India

Fragment	Distance from sanctuary (km)	Transect length (km)	Boluses/km	Dung piles/ km
Kalyanapandal	1.00	0.748	40.4	10.7
Sangli Road	0.46	1.326	13.6	2.9
Akkamalai complex	Within	5.137	5.3	1.3
Pannimade	1.85	1.224	5.9	1.8
Manamboli	Within	3.3	5.9	1.5
Tata Finlay	0.77	1.19	4.5	1.0
Injipara BP	2.77	1.902	1.4	0.4
Andiparai	Within	2.312	0.9	0.4
Puduthottam	2.57	2.227	0.0	0.0

Spearman-rank correlations of dung encounter rate with landscape, site, and habitat variables did not yield any significant strong correlations. The only variable that appeared to influence elephant use and abundance was the presence of bamboo (*Ochlandra* sp., $r_S = 0.639$, $N = 9$, $P = 0.06$). This bamboo grows as dense straggling reed-like clumps on steep slopes, along streams such as the Sholayar (e.g. near Pannimade fragment), and some disturbed areas. Distance from the sanctuary boundary appeared to have only a moderate influence on elephant abundance. However, the sites with the highest dung encounter rates were inside the sanctuary or within 2 km from the boundary.

ELEPHANT USE OF HABITATS IN THE LANDSCAPE MOSAIC

We covered 230.85 km along the seven road routes and recorded a total of 154 elephant dung piles in the different habitat types in the landscape (Table 3.3). The road survey data indicated that nearly 79% of the Valparai plateau is under monoculture plantation and settlements, spanning all areas accessible by at least dirt roads and estate roads. Tea is the dominant habitat type (45.5%) followed by plantation edge and coffee with 8.12% and 6.67%, respectively.

Elephant use of habitats varied significantly ($\chi^2 = 359.2$, $df = 3$, $P < 0.001$). Although natural vegetation (including edge) occupied only 14.82% of the plateau, over 45% of the dung piles were encountered in this habitat type. Although elephants regularly visit human settlements (often leading to incidents of human-elephant conflict), they certainly showed a clear avoidance of areas close to human habitation as the usage was only 2% as compared to 18% of available area (Table 3.3). On the

other hand, tea and coffee plantations and plantation edges were used by elephants in accordance with their availability in the landscape.

HUMAN-ELEPHANT CONFLICT AND THE FOREST-CULTIVATION INTERFACE

We recorded 157 incidents of human-elephant conflict in the Valparai plateau between April 2002 and March 2003, including one human death. Further, we carried out a spatially-explicit analysis of the relationship between the location of forest fragments and the location of 150 conflict incidents that brought elephants into close proximity of people (e.g. raiding vegetable gardens) or caused over Rs. 500/- damage per incident. The 'buffer' area of each fragment was estimated as the area of private land falling within 1 km of the fragment boundary and the number of conflict incidents within this buffer was enumerated and expressed as incidents per unit area.

We found that over the study period conflict intensity ranged from zero incidents/km² (around Andiparai fragment) to 3.2 incidents/km² (around Injipara) in the Valparai landscape. There was no correlation between conflict intensity around fragments and the encounter rate of elephant dung (r_S = -0.40, N = 9, P = 0.29). Conflict intensity in a fragment's buffer declined with increasing presence of bamboo in the fragment (r_S = -0.822, N = 9, P = 0.007) and increased with the presence of connectivity with *Eucalyptus* plantations (r_S = 0.73, N = 9, P = 0.025).

On their movements between forest areas elephants have to move through large areas of tea plantation (Pannimade rainforest fragment in the background).

Partial correlation analysis showed that *only* the effect of bamboo presence was statistically significant. Thus, conflict in the surrounding plantations landscape did not increase with increasing use of fragments by elephants, but rather, it appeared to intensify with the decreasing availability of bamboo within a fragment.

DISCUSSION

Although Asian elephants use forest habitats ranging from semi-arid dry thorn to wet evergreen forest, they attain highest densities in the moist and dry deciduous forests that contain substantial grassy and bamboo forage, a preferred food during the wetter months when there is fresh grass growth (Sukumar 1986). Within tropical wet evergreen rainforests, much of the biomass is trapped in the tree canopy and the understorey vegetation also consists predominantly of woody shrubs and climbers, of low food value to elephants. Openings in rainforest may contribute to increased use by elephants, when accompanied by greater availability of forage such as grasses and bamboos (Sukumar 1986, African elephant *Loxodonta africana*: Barnes *et al.* 1991).

CORRELATES OF RAINFOREST FRAGMENT USE BY ELEPHANTS

Surveys showed substantial variation in elephant use across the nine study fragments. Fragment size did not seem to influence elephant use, with the highest dung encounter rate being recorded in a relatively small fragment with abandoned coffee (Kalyanapandhal, 35 ha). Elephant use of fragments appeared to be related to two main factors: presence of bamboo forage and proximity to surrounding protected areas. *Ochlandra* bamboo is a highly preferred forage for elephants and their dense thickets offer ideal cover in which elephants can forage with a relatively lower likelihood of human disturbance than in the surrounding landscape. Proximity to the protected areas is also likely to be a factor influencing higher dung encounter rates in forest fragments. This is because, in addition to the focal herds we tracked, other peripheral herds from the surrounding protected areas are also likely to have used these fragments without moving into the larger area of plantations or private land.

The forest fragment of Andiparai appeared to be an exception to the general pattern of influence of bamboo and proximity to protected area in determining elephant use of fragments. Andiparai was within the Indira Gandhi Wildlife Sanctuary and contained considerable *Ochlandra* patches at the upper reaches. Lower encounter rates of elephant here was possibly because this fragment was hemmed in by two private plantation enclaves (Waterfall-Waverly and Talanar Valley estates) and was only narrowly connected to the protected area. It also occupied steep terrain and contained dense evergreen rainforest over a large proportion of the area sampled by transects and the area under dense stands of *Ochlandra* could not be penetrated and adequately covered in transect surveys.

USE OF SURROUNDING LANDSCAPE MOSAIC

Elephant use of the surrounding landscape mosaic appeared to be determined by two main factors, the first pertaining to the availability of forage and cover, and the second pertaining to human activity and the presence of human settlements. The remnant natural vegetation and its edge with other habitats on the plateau emerge as overwhelmingly important given that these habitats, taken together, were used thrice as frequently as expected. In contrast, human settlements were strongly avoided. Given that tea plantations dominate the landscape, it is expected that elephants are constrained to use them. As these plantations have virtually no forage or forest cover and contain people engaged in tea-picking and other agricultural operations throughout the year, areas identified as movement routes and corridors have to be set aside for the use and passage of elephants through the plateau.

THE FOREST-CULTIVATION INTERFACE—DOES FRAGMENT PRESENCE REDUCE CONFLICT?

Does the presence of forest fragments intensify or minimize human-elephant conflict in a fragmented landscape? Our data suggests that there is no correlation between the intensity of use of forest fragments and conflict intensity in the surrounding landscape; if anything, there is a weak negative trend suggesting that the presence of fragments (and of bamboo within fragments) may in fact reduce conflict intensity. This seems likely as the presence of rainforest fragments and other natural vegetation remnants provide forage, cover, and water, and act as corri-

dors for the relatively-free movement of elephants. As the surrounding landscape is depauperate in all these resources (as tea is inedible and coffee is only seasonally available as fruits), elephant-human conflict is not intensified by the higher forest-cultivation interface, as may happen when there are highly edible crops such as rice, sugarcane, and bananas that abut forests (Sukumar 1989, Nyhus *et al.* 2000). Spatial determinants of elephant-human conflict in land-use mosaics are as yet poorly understood and may depend on many possible factors such as male-female differences (Sukumar 1994, Sitati *et al.* 2003), habitat loss and fragmentation (Williams and Johnsingh 1986), rainfall, distance to protected areas, or human settlement density (Hoare 1999, Nyhus *et al.* 2000). A more detailed spatial analysis of conflict in relation to other site, landscape, and settlement characteristics is in progress.

Elephants at the edge of a rainforest fragment adjoining tea estate

4. Asian elephant movement routes and habitat use on the Valparai plateau

INTRODUCTION

Habitat loss and fragmentation are believed to be among the important causes for population declines of the Asian elephant (Leimgruber *et al.* 2003). In fragmented landscapes, knowledge of elephant movement patterns and routes and use of forest and man-made habitats is essential for identification and protection of corridors and for the planning of conservation and management measures. This chapter describes our study of Asian elephant movement routes and day- and night-time use of the major habitats on the Valparai plateau in the Anamalai hills. We use data from herds whose movements were tracked daily using a combination of direct day-time observations and indirect evidences of nocturnal movements and habitat use in order to present a more comprehensive picture.

OBJECTIVES

The main objectives of this part of the study were to:

1) Document elephant movement routes through the plantation landscape mosaic, and
2) Identify patterns of habitat use during the day and night by elephant herds moving through the Valparai plateau.

METHODS

We tracked elephant herds that used the Valparai plateau to document movement routes and use of rainforest fragments and other habitats. Herds were first located during regular visits to all possible forest fragments and plantation habitats and through information from a network of local estate field workers (informants). Once located on fragments or private land, elephants were observed or followed (from a safe distance or from cover to minimize disturbance to the animals) until they entered contiguous forest tracts in the surrounding protected areas. We tried to obtain at least one or two daytime locations and back-tracked herd movements to determine routes taken overnight. While tracking the route used by a herd on foot or by vehicle, we noted the exact GPS locations for the entry point into the plantations from the surrounding pro-

tected area, locations of direct sightings, indirect evidences (dung, tracks, feeding signs), and conflict incidents. GPS locations were also taken approximately every 0.5 km along the elephant herd's path to determine the movement direction and habitats used. The herd's age-sex composition, habitat, movement direction, conflict incident records, and estate name, were also noted. Elephant herds were identified on successive days using at least one or more individuals with identification marks (e.g., nicks and holes in ear, cut tail, etc.) and on the basis of the herd's age-sex composition.

Between April 2002 and March 2003, 742 locations were obtained of elephant herds moving through the plateau. A random subset of 343 locations (a maximum of one daytime and one night-time location per herd per day) selected to minimize the effects of spatial auto-correlation were used to document use of major habitats and the day- and night-time differences (χ^2 tests, Zar 1999). GPS locations of herds were overlaid on digitized maps of the study area to examine spatial distribution patterns.

RESULTS

HERD TRACKING: ELEPHANT MOVEMENT ROUTES

We tracked 14 herds of elephants numbering 162 individuals (average herd size = 11.6, range 7–20) that entered and moved across the fragmented landscape mosaic of the Valparai plateau (Appendix 1). Although elephants ranged widely across the plateau during their movements, these locations clustered along one major route through the central part of the plateau (Figure 4.1). A significant amount of time was spent by various herds particularly along the riverine vegetation, fragments, and *Eucalyptus* fuel clearings along the Sholayar and the Nadu Ar (Ar = river) that feed into the Sholayar reservoir (Figure 4.1). This route went through estates such as Pannimade, Murugan, Injipara, Gajamudi, Sirikundra, and Nadumalai, belonging to at least five major plantation companies in the area. Most of the movement was from the reserve forest and sanctuary areas on the west and south towards areas on the east and northeast of the plateau (Figure 4.1).

ELEPHANT USE OF HABITATS IN THE LANDSCAPE MOSAIC

We analysed the distribution of elephants across four major habitats (tea, coffee, and *Eucalyptus* plantations and rainforest fragments) using direct sightings, indirect evidences, and conflict records. There was a significant variation in elephant use of habitats (χ^2 = 98.5, *df* = 8, *P* < 0.001). Data from direct sightings showed that elephants were seen most frequently in forest fragments (40.2%) and *Eucalyptus* plantations (26.8%). However, the percentage use was highest in tea plantations based on both indirect evidence (62.0%) and conflict records (77.6%). Around 19% of the conflict incidents were in coffee plantations, whereas less than 13% of the direct sightings or indirect evidence was from this habitat (Figure 4.2).

This pattern was partly due to significantly different daytime *versus* night-time use of the four major habitats by elephants (χ^2 = 359.2, *df* = 3, *P* < 0.001). We compared habitats used by elephants in 166 daytime

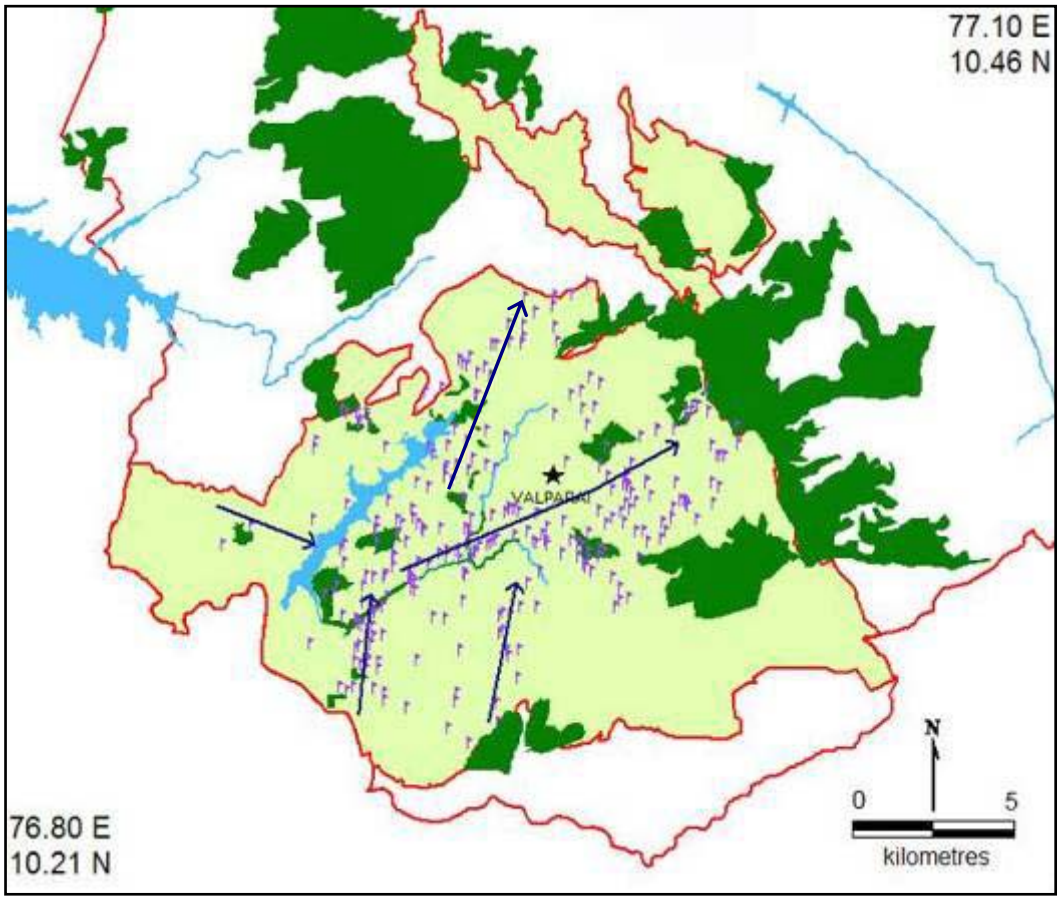


Figure 4.1: Locations of elephant herds (*N* = 343 locations) in plantations (light green), rainforest fragments (dark green), reservoirs and major riverine areas (blue) on the Valparai plateau. Arrows indicate general direction of movement of elephant herds.

(0600–1800 h) and 177 night-time (1800–0600 h) locations of herds. Nearly two-thirds (65.1%) of elephant locations during daytime were in rainforest fragments and *Eucalyptus* plantations (Figure 4.3). In contrast, at night, two-thirds of the locations (66.1%) were in tea plantations and usage of forest fragments and *Eucalyptus* plantations declined to 20.9%. Coffee plantations, which usually contained many native and canopy shade trees but little in the understorey besides coffee bushes were used about 13% of the time both during day and night.

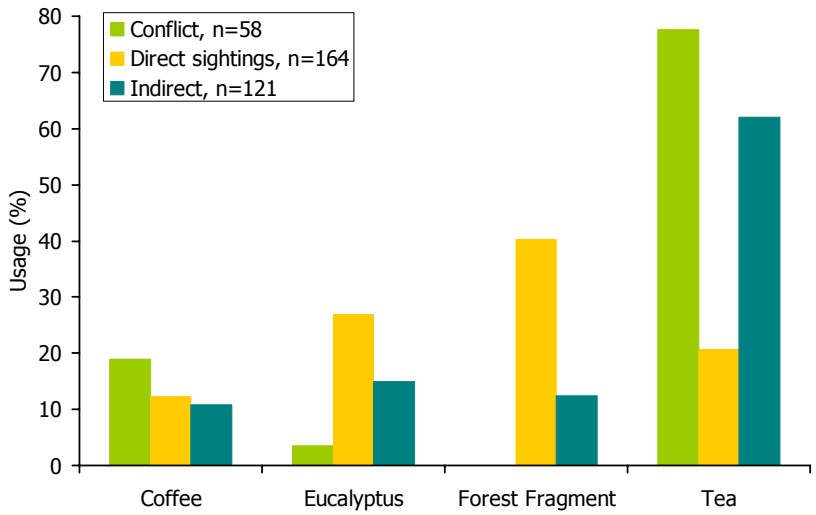


Figure 4.2: Elephant use of four major habitat types on the Valparai plateau, Anamalai hills—differences between conflict records, direct sightings, and indirect evidences from herd tracking.

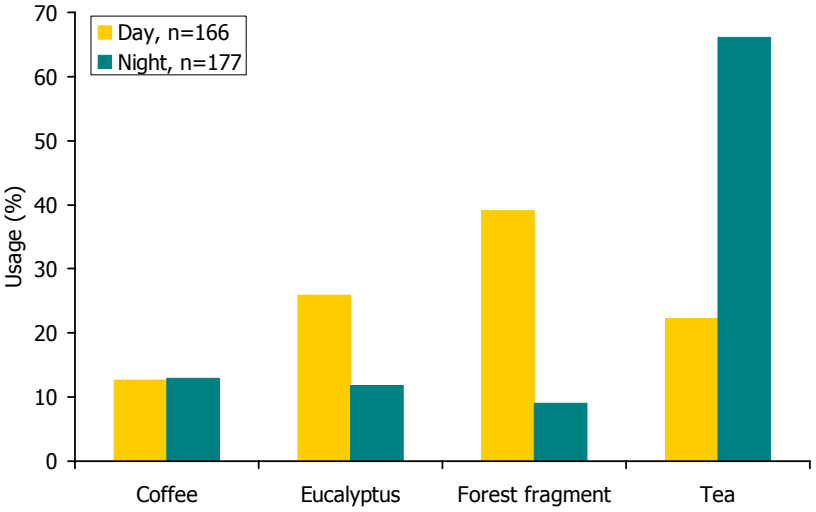


Figure 4.3: Variation in elephant use of four major habitat types on the Valparai plateau, Anamalai hills—differences between daytime and night-time herd tracking records.

DISCUSSION

An earlier study on the distribution of large mammals in Anamalai hills (Kumar *et al.* 2002) revealed that elephants showed a seasonal movement pattern from west to east during the wet season and from east to west during the dry season. The broad direction of movement of most elephant herds across the Valparai plateau during the wet season months of the study (June to October) conformed to this trend. During this movement, distance from the protected area boundary had only a weak or secondary influence on elephant movement. Instead, elephants intensively used a central portion of the Valparai plateau relatively far from the sanctuary boundaries. Here, elephant movement appeared to be determined by the use of low-lying undulating terrain and riverine secondary vegetation along the Sholayar and Nadu Ar river valleys. ***This represents the principal movement corridor across the centre of the Valparai plateau.*** It must be noted that elephant herds were not observed returning to the west and south west along this route during the dry months, indicating that other routes through the surrounding protected areas must exist.

During the day, elephants were mostly seen in rainforest fragments and other natural vegetation remnants such as secondary and riverine vegetation, where they spent considerable time feeding on *Ochlandra* and other vegetation, and resting. At night, elephants moved through tea plantations and other habitat types under the cover of darkness, and their use of these habitats was registered through indirect evidences such as dung and tracks. As in other studies (Sukumar 2003), virtually all conflict incidents occurred at night and these tended to be mostly in tea plantations. The use of a combination of techniques in this study has helped clarify the landscape level patterns of habitat use as well as illustrate the dramatic day-night shifts in habitat use by elephants.

The importance of *Eucalyptus* fuel-wood plantations in addition to rainforest fragments as daytime refuges in tea estates also emerges from this study. These plantations, occurring as blocks or linear strips, often along or adjoining streams, can function as corridors for movement through the otherwise open landscape of tea plantations. The *Eucalyptus* plantations, known as fuel clearings, are clear-felled at regular intervals to extract fuel-wood and timber for use in the tea factories in a highly regulated system, wherein the trees are replanted or coppiced. Although

Elephants in the Valparai landscape prefer to use streams with riparian vegetation. Here elephants move through a tea estate towards riparian vegetation. On the right tea is planted up to the water's edge—a common sight in Valparai—and on the left *Eucalyptus* trees are being felled causing disturbance to natural regeneration at the river's edge.

such felling may create disturbance and interference in elephant movements, the process of clear-felling cannot, and perhaps should not be halted, as it would intensify need for timber and fuel-wood from forest areas. Instead, felling operations in *Eucalyptus* areas frequently used by elephants, such as along the Sholayar stream, could be only partial (i.e., not all trees are felled). Regulations need to be enforced through the District Forest Committee (the statutory authority that oversees felling permits) to ban felling or disturbance to re-growth vegetation within a fixed distance of around 30 m on streamsides.

5. Human-elephant relationships on the Valparai plateau

INTRODUCTION

Large-scale loss, conversion, fragmentation, and degradation of natural habitats due to exploitation, development, and expansion of human activities including agriculture, are the main threats to wild species the world over. Fragmentation of prime habitats often brings elephants into contact with humans, leading to incidence of human-elephant conflict (Santiapillai and Jackson 1990, Sukumar 1994, Hoare 1999, Williams *et al.* 2001, Madhusudan and Mishra 2003) that may hamper conservation activities in wildlife habitats abutting human habitations. Past studies have proposed various reasons for conflict and resolution measures to reduce or eliminate the conflict. In the fragmented landscapes of Valparai, it is inevitable that wide-ranging elephant movements associated with foraging and seasonal migrations across the plateau (Kumar *et al.* 2002) will continue, thereby bringing the animals into contact with people and aggravating the potential for conflict. Recently, there has been widespread impression of intensifying human-elephant conflict on the Valparai plateau in the Anamalai hills (Palaniappan 2002). Therefore understanding, assessing, and quantifying human-elephant conflict is required before any conflict resolution measures are suggested to conserve elephants.

OBJECTIVES

The main objectives of the human-elephant conflict study were to:

1) Describe the nature, frequency, and distribution of conflict incidents over space and time on the Valparai plateau,
2) Estimate the monetary costs of conflict to various companies, agencies, and individuals, and
3) Suggest remedial measures required for reducing conflict and enhancing people-elephant coexistence in the long-term on the Valparai plateau.

METHODS

We visited the locations of all conflict incidents either recorded by us while tracking herds or reported by informants and carried out on-site

assessment of damages. We noted the date, time of incident, estate name, company, nature and extent of damage, type and amount of material lost, GPS location, immediate surrounding habitat, main habitat within 500 m radius of site, and herd composition (wherever possible). We attempted to itemise and estimate damage as accurately as possible. For instance, for damage to buildings we noted details such as the number of damaged tiles, windows, doors, wooden reapers, etc., and surface area (m^2) and materials (stone and mud, brick and concrete) of walls and revetments. For loss of provisions, we noted items (rice, lentils, etc.), quantity (number of sacks and weight in kg), and ownership (private, company, or government ration stock). Market costs of each item and labour costs of repairs were obtained through consultation with local shops, contractors, and estate records. This was used to estimate the monetary costs of each conflict incident. Larger costs (damage to vehicles, buildings) were verified against reported repair costs or insurance claims filed by companies. We also noted raids of banana gardens (at Rs. 50 per plant destroyed). Multiple damages at sites <200 m distant on the same night were considered as a single conflict incident.

To test the widespread local belief that the cultivation of banana plants in colonies provoked elephant visitation, we surveyed 80 random colonies on the plateau. Here, we noted settlement name, estate, company, number of houses and people, GPS location, and banana presence. People were interviewed to determine whether during the last one year (2002-2003) bananas were grown there, the number of times elephants visited the colony, and whether any damages occurred.

We also obtained conflict incident details and costs from the records of some local companies. The amount of loss estimated by the companies was treated as perceived cost of conflict. We also interviewed company managers to determine if they had any life or property insurance against elephant damage.

Information on each human death due to elephants in the last 10 years (1994 – 2003) was collected from the Tamil Nadu Forest Department, the State Police Department, and company records, and verified through field visits and interviews with local people. The information included name, age, and sex of the person, location of death, habitat (from our field survey), date and time of incident, amount of compensation paid, and any other description of the incident, if available.

RESULTS

NATURE OF CONFLICT

We recorded 157 conflict incidents over a one-year period between April 2002 and March 2003 (we excluded 7 incidents that had negligible costs associated with them, such as damage to an abandoned building or to a few tea bushes or garden plants). The 157 incidents of conflict included one human death, 89 (56.3%) *major incidents* that caused a damage of over Rs. 500 (c. USD 12) per incident, and 67 (42.4%) *minor incidents*. The major incidents of conflict were mainly of the following types (Figure 5.1): damage to buildings (117 incidents), raiding stored provisions (31 incidents), damage to banana and vegetable gardens around colonies or bungalows and crop damage (53 incidents), and others (8 miscellaneous incidents such as damage to manure sacks, office equipment, and motor vehicle). In 106 incidents there was only one type of damage, 47 had two types (e.g., building and provisions), and 3 incidents represented damage to three types (e.g., buildings, provisions, and banana plants damaged in the same incident). There was no serious crop-raiding. Elephants in coffee estates consumed some quantity of berries, destroyed few coffee bushes as well as pushed over and consumed roots of *Erythrina mysorensis* used as shade trees. Tea plants were never consumed, although on two occasions loss was suffered when plucked crop had to be abandoned when elephants came to the vicinity.

Excluding the compensation paid for one human death (Rs. 100,000), the overall cost of conflict over the one-year period was estimated to be around Rs. 503,245 (our estimate) and Rs. 658,116 (including costs perceived by companies for a few major incidents). Because the response of people to conflict situations is likely to be influenced by perceived loss rather than measured loss, we use estimates of perceived loss in all further analysis. The loss ranged up to Rs. 75,850 per incident averaging Rs. 4038 per incident, with just 24 (15%) incidents accounting for 75% of the total cost. These 24 incidents mainly involved building damage and raiding of stored provisions with a few exceptions (damages to tea saplings in nursery, electric fence, plucked tea crop, coffee crop, and motorcycle). The total cost was highest for building damage (Rs. 380,893) followed by loss of stored provisions (Rs. 178,704), garden plants (Rs. 80,270), and other damages (Rs. 18,250).

Building damage (Monica estate muster)

Building damage (Monica school noon-meal centre)

Raiding provisions (Nadumalai ration shop)

Banana plants damaged by elephants

Field conflict assessment (Injipara school)

Government officials being shown conflict site

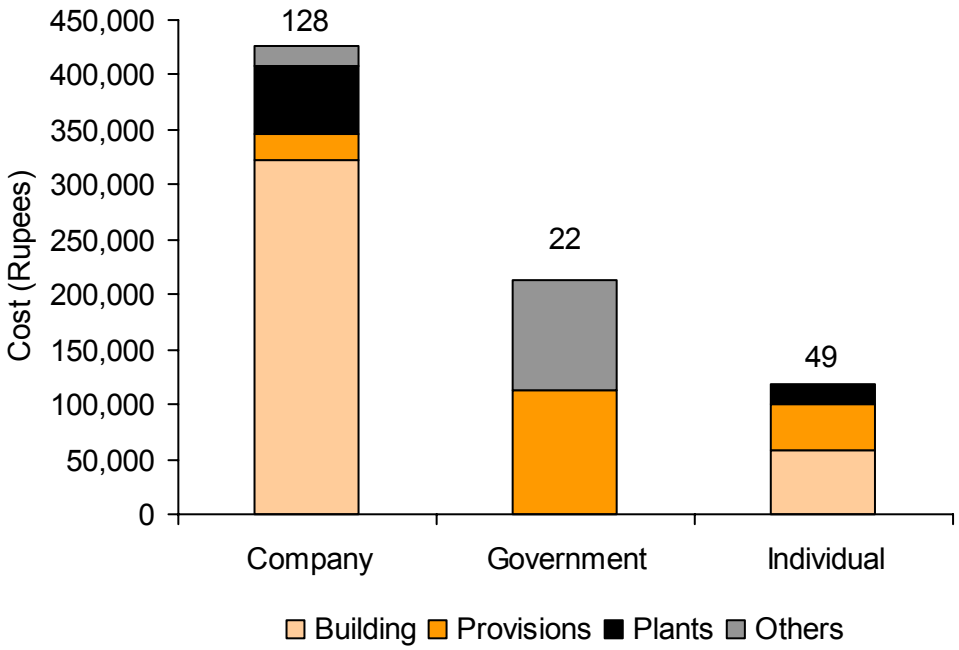


Figure 5.1: Cost of elephant damage to life and property on the Valparai plateau between April 2002 and March 2003. Number of incidents is indicated above bars and includes one human death for which compensation was paid by the State Forest Department. The same incident may have resulted in different costs to company, government, and individuals.

The major economic impact was on seven private companies (Appendix 2) that were affected mainly due to building damage, followed by the state government that paid compensation for one human death and suffered some loss of provisions. In addition, a lower fraction of the monetary costs of conflict was also borne by individuals whose buildings and provisions were destroyed, besides damage inflicted on banana and vegetable gardens near their houses (Figure 5.1).

WHERE DO CONFLICTS OCCUR ON THE PLATEAU?

Conflict incidents were widespread but more frequent and intense towards the centre of the Valparai plateau than in locations adjoining the protected areas (Figure 5.2). We did not gather location data on all conflicts in the extreme western (Malakiparai, Sheikalmudi) and south-eastern

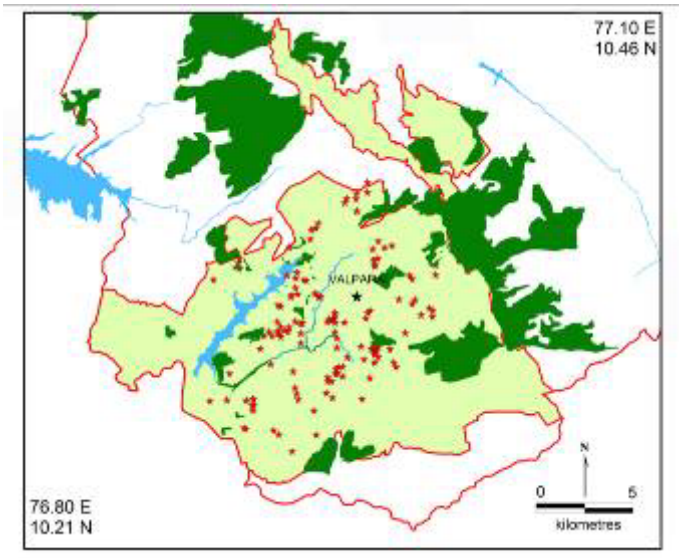


Figure 5.2: Locations of conflict incidents on the Valparai plateau.

(UPASI, Tantea) parts of the plateau, and in Talanar and Waterfall. Our records and consultation with local companies showed relatively less conflict in these areas, although elephants frequently occurred there.

Thus, estates in companies such as Hindustan Lever Ltd., BBTC, and Jayashree Tea, which did not abut the sanctuary, were those that had greater incidence of conflict. This pattern of greater conflict towards the plantation interior was accentuated when the spatial distribution of conflict costs was compared with spatial distribution of conflict incidents (Figure 5.3).

Figure 5.3: Spatial distribution of the frequency of conflict incidents (left) and costs of conflict (right) on the Valparai plateau. Higher intensities and costs are in red. Note the clustering towards the central part of the plateau away from the boundaries with the surrounding protected areas.

WHEN DO CONFLICTS OCCUR ON THE PLATEAU?

Although conflict incidents were recorded throughout the year, there was a distinct peak in conflict between October and January (Figure 5.4). Of the total cost of conflict over the one-year period, 85% was incurred between these months, which corresponded to a period of greater elephant usage of the plateau. In four companies that incurred a total loss of over Rs. 30,000, 81% to 98% of the losses occurred during this peak conflict period (Appendix 2).

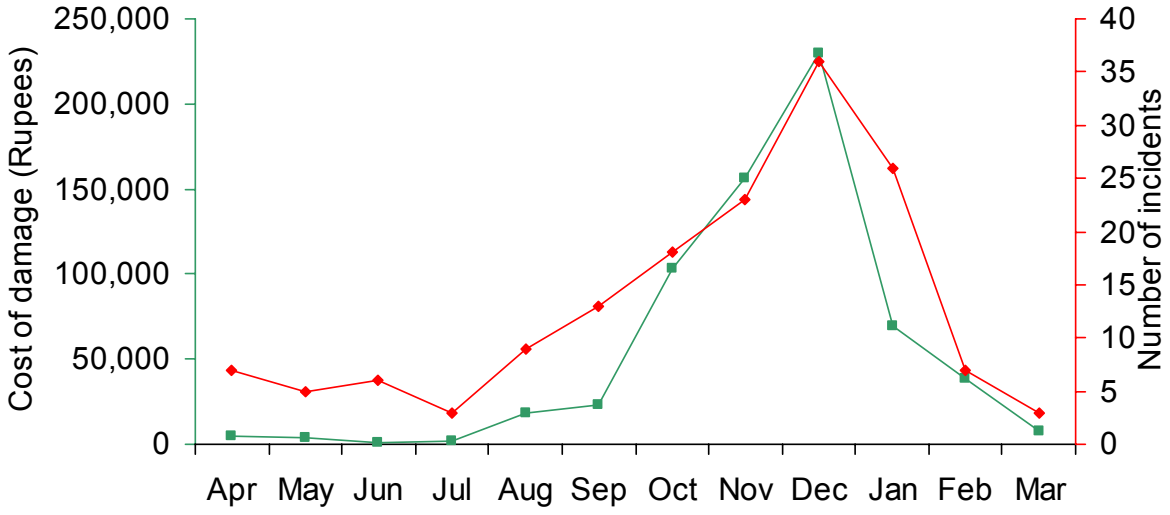


Figure 5.4: Temporal distribution of the frequency of conflict incidents (red line) and costs of conflict (green line) on the Valparai plateau. More incidents and higher costs were noted between October 2002 and January 2003.

HUMAN DEATHS DUE TO ELEPHANTS (1994 – 2003)

We examined records of the loss of human lives due to elephants over the last 10 years (1994 – 2003) in Valparai Range and Manamboli Range. These two Ranges, which covered a total area of 530 km², included the 220 km² of the plantations on the Valparai plateau as well as

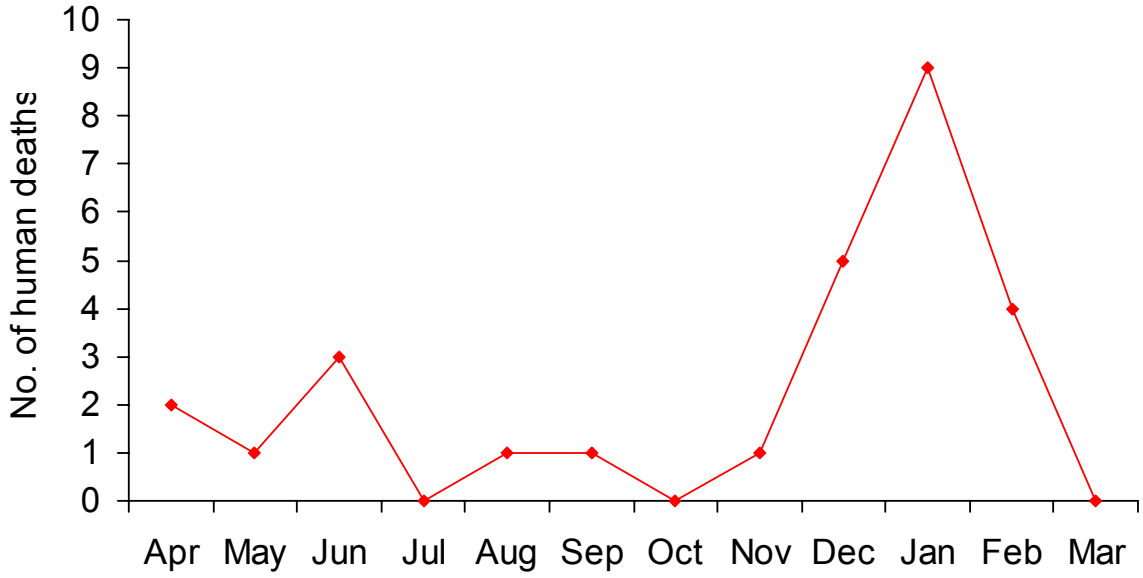


Figure 5.5: Loss of human lives due to elephants over a ten-year period (1994-2003) within the Valparai plateau (Valparai and Manamboli Ranges). More deaths occurred between December and February.

surrounding forest areas within the Indira Gandhi Wildlife Sanctuary. Data compiled from Forest Department, Police Department, and company records indicated 27 human deaths over this ten-year period (Appendix 3). Between one and five people lost their lives every year, with an average of around three human deaths annually.

The records clearly indicate that there have been deaths in almost all months but more deaths occurred during December, January, and February (Figure 5.5). Notably, all deaths were in plantation areas and not within the sanctuary (one was at the edge). Some deaths occurred near forest fragments, others were all within tea and coffee plantations. The location and circumstances of these incidents are being compiled.

DOES CULTIVATION OF BANANA PLANTS INCREASE LIKELIHOOD OF CONFLICT?

Elephant herds frequently visited labour quarters or passed very close to these houses during their movement through the plateau. We investigated whether this was influenced by the cultivation of bananas around these houses (N = 80 colonies surveyed). The incidence of at least one visitation by elephants over the previous year was only slightly lower in colonies with no bananas (65%) compared to those that cultivated few (71%) to many banana plants (81%).

DISCUSSION

Human-elephant conflict in the Valparai plateau differs from that in most other parts of India in two major ways. First, conflict is mainly due to damage of buildings where provisions are stored and crop-raiding is negligible as elephants do not feed on tea, the dominant crop in the landscape. Second, almost all incidents recorded were due to elephant herds numbering 7 to 20 elephants and were not because of bull elephants, which are responsible for a disproportionate amount of conflict in other places (Sukumar 2003). ***The potential for resolving conflict and augmenting coexistence of people and elephants is also higher in the Valparai plateau than in other regions of Asia. This is because the overall costs are not high, incidence of conflict is fairly predictable, and measures to offset or minimise conflict can be effectively instituted (see next chapter)***.

The higher intensity of conflict towards the interior of the plateau is likely to be related to several factors. The lack of forest areas in close

proximity that provide natural forage is one possible factor. The presence of boundaries between many estates in this area is another possible factor as elephants were often harassed and chased from one estate to another with no coordination between companies. Harassed elephants were often isolated during the day in the middle of tea plantations in hot sun or in other sites with no natural forage, possibly making them seek out food grain stores at night to meet their food requirements. Finally, many sites may have been more susceptible to conflict as they were close to the major movement route of elephants passing through the middle of the plateau (Chapter 4).

The preponderance of conflict between October and January is likely to be related to elephant movements. Observing a similar pattern in crop-raiding elephants in the Biligirirangan hills, Sukumar (1989) concluded that this was related to crop harvest and the nutritional value of crops *vis-à-vis* natural forage. In Valparai, as elephants did not raid crops, it seems more likely that this period was a time when elephant herds moved from protected areas in the west to those in the east and came into conflict with people for reasons mentioned above. The influence of elephant movement patterns on conflict has been asserted by Tchamba (1996) for African elephants (*Loxodonta africana*) in the Cameroon. Although our data for conflict is only for one year, the likelihood of this being a general pattern emerges from the 10-year data on human deaths due to elephants, which also indicated this as a peak period for the occurrence of such incidents.

Two caveats need to be added. The study mainly focussed on herds that moved through the plateau spending between 2 and 68 days continuously in plantations. It did not record all incidents of sporadic conflict arising from a few peripheral herds that ventured into the plateau from surrounding protected areas only to return within a day or two. These, however, did not involve any major incidents and is unlikely to significantly change our findings and conclusions. Secondly, it was not possible to quantify some damages such as pushed-over *Erythrina* shade trees in coffee estates (these were often simply rooted back in place or replaced by cuttings), the trauma to people because of the presence of elephant herds just outside their mud-and-stone-walled houses, and other hindrances to normal work and activity (such as difficulties in getting to work or school because of elephants on the path).

6. Threats, conflict resolution measures, and implementation

THREATS

Two features of the Valparai plateau that pose threats to the long-term conservation of Asian elephants are: (i) the continuing degradation of rainforest fragments and riverine vegetation, and (ii) the conversion of shade-coffee, *Eucalyptus*, and cardamom plantations (important feeding and sheltering grounds for elephants) to tea and other plantations that are virtually devoid of forage and cover, or excluded by modern power fences.

One major factor influencing degradation of forests in this landscape is fuelwood collection by local people. In a few places, we have noticed that it is not just fallen wood that is collected but trees are girdled or felled for the purpose. While strong action is required against unauthorised felling and girdling, authorities along with conservationists and local companies need to simultaneously find suitable alternatives for local people who have a genuine need for fuelwood for cooking, heating water, and warmth to dry their clothes in this heavy rainfall area. Some companies have offered loan schemes to assist about 40-60% of their permanent employees to purchase liquefied petroleum gas (LPG) cylinder-stove connections. This needs to be taken further to reach all employees. Feasibility of alternative water-heating systems, such as *hamams* (energy efficient water heater) and solar water-heaters, is being explored with private companies. We suggest that steps are taken by local administration and forest department authorities to ban the use of locally procured fuelwood for cooking in commercial establishments such as hotels and tea shops.

The results from this study suggest the need to retain and protect all natural vegetation remnants and riverine vegetation on private lands, and enforce policy changes to regulate felling operations in *Eucalyptus* plantations, particularly along elephant movement routes (such as along the Sholayar river).

The conversion of plantations from those with more shade tree cover (such as coffee or cardamom) to those with less or no shade (tea) also needs to be squarely addressed and stopped, an aspect already noted in other studies from this region (Umapathy and Kumar 2000, Kumar *et al.* 2001). Proximate threats to elephant conservation in this

landscape include the degradation and conversion of 'safe-passage corridors' that not only help elephants but also would contribute to averting conflict that would otherwise be inevitable.

In the long run, large scale developmental changes to the landscape including dams and reservoirs, intensified settlement, and land-use conversions are likely to intensify conflict given that source populations of elephants in the neighbouring reserves are fairly secure and will likely continue using the Valparai landscape in their seasonal movements. It is essential to plan wider developmental changes on the plateau keeping this in view.

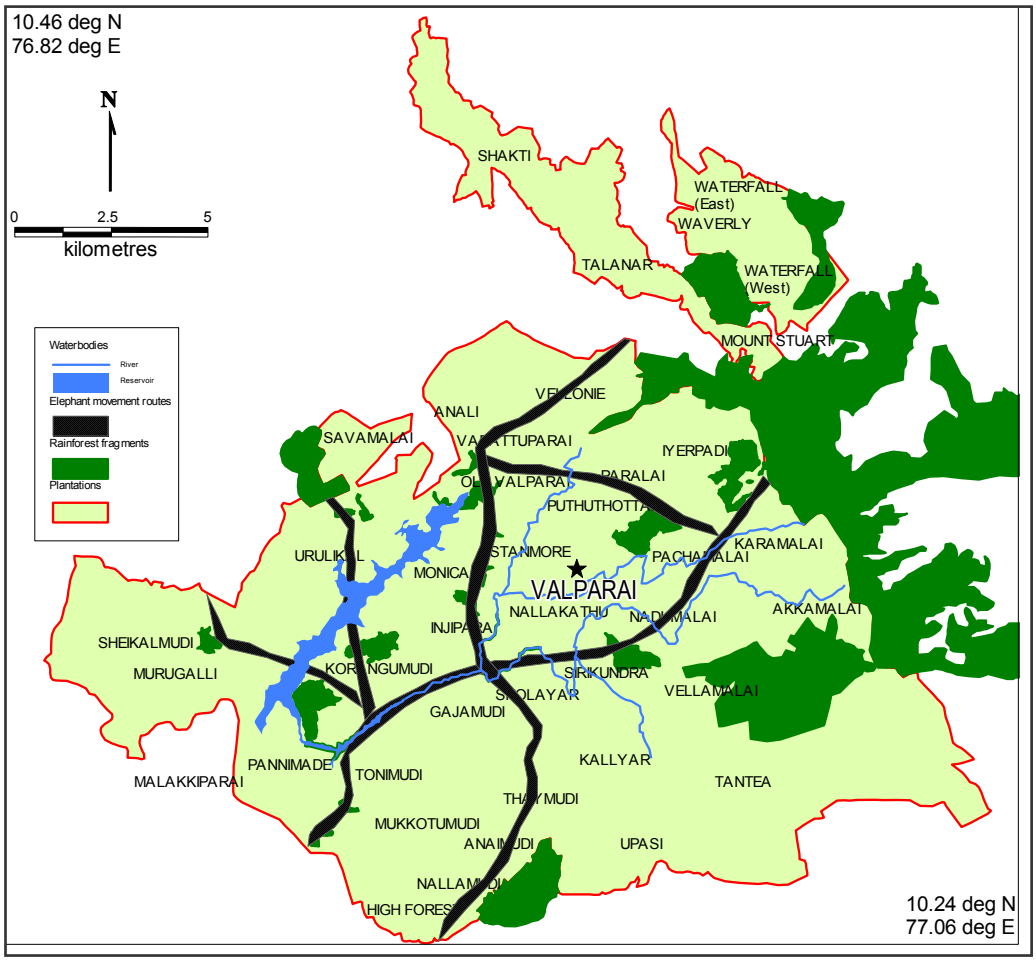
CONFLICT RESOLUTION MEASURES

A primary aspect to keep in mind when planning elephant conservation measures in this region is the value of rainforest fragments not only for elephants but even for other highly endangered wildlife species of the region. A number of studies carried out in this region highlight the importance and role of forest fragments in the management of endemic and endangered wildlife such as primates and small mammals (Kumar et al. 1995; Singh et al. 1998, Mudappa 2001), herpetofauna (Vasudevan 2000; Ishwar 2001), avifauna (Raman 2001), and invertebrates (Babu 2000). These studies have highlighted the value of rainforest fragments as refuges for many species, thereby allowing the persistence of larger populations at the landscape level, and as corridors for movement and dispersal of species such as large mammals and wide-ranging birds (Kumar et al. 2002, Raman and Mudappa 2003). With this in mind, we propose the following conflict resolution measures to be implemented.

ENHANCING COEXISTENCE

The presence of elephants on the Valparai plateau is a reality that cannot be wished away. The **only** long-term measure to alleviate human-elephant conflict in the plantation-dominated Valparai landscape is the implementation of pro-active steps that incorporate an understanding of the food and range requirements of wild elephants. Land-owners and companies should:

1. Set-aside and protect regularly-used movement routes of elephants through the plantation landscape (see map).



2. Protect from felling, conversion, grazing, fuel-wood collection, and disturbance, all surviving forest and natural and secondary vegetation patches within the plantations.
3. Adopt a controlled (partial) felling regime of *Eucalyptus* fuel-wood plantations, particularly along movement routes and streams.
4. Avoid clear-felling (see photographs below), and leave at least 25 m of vegetation buffer from stream edge.
5. Regenerate or restore habitat along movement routes (e.g., along Sholayar, Nadu Ar, Sirikundra rivers) with natural vegetation and bamboo.
6. Implement a strict policy of "*no harassment and no obstruction*" of elephants during their daytime movements and feeding (see photograph on the right).
7. Property and life insurance should be made mandatory by all private companies and landowners in this ecologically rich and sensitive region.

DETECTION AND AVOIDANCE

Anticipating potential conflict and avoiding it would be possible if elephant herds are detected early enough and not located only **after** an incident has occurred. Simple steps to detect elephants can be taken:

1. ***Wildlife has no borders***. Therefore there should be within- and between-company communication and cooperation to increase awareness of elephant presence, prevent harassment of elephants by people, and facilitate their passage across the Valparai plateau in the minimum time.
2. Simple, trip-wire alarm systems and signal lights may be installed around labour colonies to warn people of the presence of elephants in the immediate vicinity at night.
3. As a matter of policy, efforts should be made to reallocate work and workers to fields without elephants, instead of chasing elephants that are trying to move through estates. Early detection and appropriate planning can ensure that no lives, resources, or

time are lost.
4. Implement programmes to improve awareness, tolerance, and understanding of wild elephants and their needs for all sections of Valparai society, estate workers, managers, school children, and others.

Deterrence

Deterrence is the first thing that people think of in human-wildlife conflict, but should probably be used as the last resort to tackle critical conflict situations and as a supplement to long-term and holistic efforts.

1. In the food-scarce plantation landscape, noon-meal centres, shops, and provision stores are visited and damaged (often repeatedly) by elephant herds in search of food. Such places can be protected by sturdy, well-designed modern power fences. This is economically and ecologically preferable to power-fencing large areas of estate, which merely creates obstructions to movements, leaving many housing colonies and stores exposed to elephants.
2. Strong physical barriers (sturdy barrier-fence using railway lines) may also work around buildings, although this is yet to be tested in field.
3. Centralized storage of food-grains at a well-protected location, coupled with immediate distribution can decrease the likelihood of damage and reduce associated costs.
4. Storing food-grains in underground or basement storage rooms may also reduce the risk of damage from elephants.
5. Another option is to store food-grains in plastic or tin bins rather than gunny sacks to minimise their detection by elephants from the emanating odour.
6. Removing banana plants around housing colonies may only reduce elephant visitation to these areas slightly. Human habitations close to movement routes and water-bodies are likely to be visited by elephants irrespective of whether they grow banana and other plants or not. We suggest that all banana and other garden plants are cultivated at some distance (at least 30 m) away from human habitation to minimise close encounters between elephants and people.

IMPLEMENTATION AS A COLLECTIVE RESPONSIBILITY: ROLES OF VARIOUS STAKEHOLDERS

S. No.		Recommendations	Responsibility for action/implementation				
			Govt.	FD	PC	CA	LP
A		**POLICY**					
	1	Identification of movement routes and corridors		X		X	
	2	Declaration and protection of movement routes and corridors	X	X	X		
	3	Protection of riverine vegetation (30 m on either side of important streams)		X	X		
	4	Regulation of felling (no felling along streams, only partial felling on movement routes)	X	X			
	5	Invest in insurance of property and life	X		X		X
B		**FIELD ACTIVITIES – modifications in attitude and behaviour**					
	1	Tracking and population monitoring		X		X	
	2	Patrolling and checking harassment of elephants by the people		X	X		X
	3	Education and awareness programmes			X	X	
	4	Communication of elephant presence		X	X	X	X
	5	Setting up warning and alarm systems to indicate the presence of elephants to people			X		X
	6	Immediate distribution/use of food grains at ration shops, stores, and schools	X		X		X
	7	Reallocation of plantation work in the presence of elephants					
C		**PRO-ACTIVE INTERVENTIONS**					
	1	Modern power-fences/barriers using rail-plates to protect vulnerable buildings (such that elephant movement through plantations is **not** obstructed)	X	X	X	X	
	2	Centralise storage of grains and other materials for public distribution	X		X		
	3	Maintain vegetable and banana gardens away from human habitation			X		X
	4	Restoration of rainforest fragments and movement routes		X	X	X	

Govt. – State Government, including local administration (town panchayat), schools, and electricity board; FD – Forest Department; PC – private companies and landowners; CA – conservation agencies; LP – local people.

STEPS TAKEN BY COMPANIES TO IMPLEMENT OUR RECOMMENDATIONS

PROPERTY INSURANCE

As the major loss due to elephant-human conflict was damage to buildings, we explored the possibility of offsetting these costs through insurance of buildings. During interviews we learnt that one company (BBTC Ltd.) had property and crop insurance and had managed to recover losses. The need to implement similar schemes was suggested to other companies. One other company (HLL) has identified and insured critical buildings on their property.

CIRCULAR COMMUNICATED

BBTC, Tata Tea Ltd., and HLL have communicated circulars (Dos and Don'ts) to their workers regarding behaviour in the presence of elephants. These steps were taken whenever an undesirable incident occurred. We are trying to make it a regular part of their personnel management. Based on our data and the understanding of the elephant movement and use of the Valparai plateau, we have been able to give specify cautionary steps to be taken during the peak conflict period (Oct-Feb).

STORAGE AND DISTRIBUTION

With repeated damage to ration and noon-meal scheme stores in schools, we have managed to convince some of them to change their practices of storing and distribution. They have been advised to keep the minimum amount required for daily use or distribution and in fewer locations. Some of the private stores are following our advice.

ELECTRIC FENCING: NOT DONE/PENDING

We have proposed to the plantation managers through the Anamalai Planters' Association (APA), Anaimallai Biodiversity Conservation Association (ABCA), and directly to the companies, the probable advantages of protecting some of their important buildings (stores and schools) and labour settlements using modern power fences. Specific locations repeatedly visited by elephants have been identified from the study. Further discussions are on regarding implementation of this suggestion.

OUR EFFORTS

Our recommendations can be implemented only with the consent and help of the Tamil Nadu Forest Department and the co-operation and willingness of the plantation companies. Therefore we thought it necessary to communicate frequently to the concerned wildlife and plantation managers the progress of our project and the findings. This was done in the following manner:

DISCUSSION MEETINGS

1. **Project initiation meeting**: A meeting was organised with the help of ABCA in July 2002 at Valparai to discuss the proposed project and seek permissions from the landowning companies to carry out the work. During this meeting we also welcomed their suggestions in order to incorporate their requirements from the study. About 40 plantation managers, the wildlife warden, forest department range officers and staff, and the local administration (Panchayat) chairperson participated in the meeting.

2. **Workers' interaction meeting**: On 30th November 2002 in Pachamalai staff club, we assembled the members of "works committee" of five estates (three companies) lying along the important elephant movement route for an interactive discussion on how to deal with elephants. During this meeting we tried to emphasise the need for co-ordination between various estates and companies to facilitate elephant movement without harassment thereby minimising conflict incidents.

3. **Workshop for press reporters**: A meeting-workshop was held on 31st May 2003 at Valparai. The target audience were the press reporters of local and regional newspapers and television, and forest department personnel. The resource people were the wildlife scientists of the Nature Conservation Foundation, the Wildlife Warden of the Indira Gandhi Wildlife Sanctuary, Mr. V. Ganesan, and other researchers working in this area. Mr. Theodore Baskaran, a noted nature writer and columnist, was the chief guest. The objective of this meeting was to sensitise the press regarding the fundamental reasons for human-elephant conflict in this region, avoid alarmist reports portraying elephants in negative terms

without an understanding of their ecology and behaviour, and to highlight the importance of factual reporting that will enable to spread conservation awareness among the local people.

4. **Understanding human-elephant relationships in Valparai**: A discussion-meeting with this theme was organised for the wildlife managers and plantation managers in Valparai on 30th November 2003. Dr. A. J. T. Johnsingh was invited to give the key note address that covered the ecology and conservation of the Asian elephant. The project team members presented their key findings to the managers, followed by a discussion of possible resolution measures that could be implemented on an experimental basis. Wildlife Warden, Mr. V. Ganesan, forest department staff, wildlife researchers, colleagues from the Nature Conservation Foundation, and about 70 plantation managers participated at this meeting.

5. **Follow-up meeting**: A more specific meeting was called for by the Anamalai Planters' Association to consult the project team on 14th April 2004 to further discuss the initiatives that could be taken. Representatives of all the major landowning companies were present at the meeting. The managers acknowledged and called for setting aside corridors of natural vegetation for elephants along the identified movement routes. Implementation of insurance schemes, electric fencing, and awareness programmes was discussed.

IDENTIFICATION OF ELEPHANT MOVEMENT ROUTES

The project has identified and highlighted to plantation and wildlife managers the key habitats used by elephants and their routes of movement through the Valparai plateau. Understanding these routes and the broad direction of movement (mostly towards the east and northeast across the plateau) is essential to prevent purposeless harassment and uncoordinated chasing of elephants back and forth between estates.

1. The Forest Department needs to take steps to protect and set aside these movement routes, particularly along the major rivers. Where there is natural riverine or second-growth vegetation these should

be demarcated, protected, and prevented from further conversion. Where there are *Eucalyptus* fuel clearing areas, felling permits should not be given for trees within a belt of 30 – 50 m adjoining the rivers and natural vegetation should be allowed to regenerate. Where tea has been planted up to the river's edge, government authorities should explore the possibility of providing incentives and tax sops to companies to regenerate vegetation as riparian forest along these areas.

2. Field visits with Forest Department and Project Elephant officers and staff were carried out to visit important sites along the movement routes (e.g. along the Sholayar river). The Wildlife Warden, Mr. V. Ganesan and Range Officer, Mr. Murthy, along with other forest staff were taken to these sites in July 2003 and steps for protection and regulation of felling were discussed on field. We also took the Director, Project Elephant, Mr. S. S. Bist along with the Conservator Forests, Dr. T. Sekar, and Range Officers on 30th December 2003 for a field visit to a conflict site and discussed the results and recommendations of our project with them.

Appendix 1

Details of Asian elephant herds tracked during the study (April 2002 to March 2003) on the Valparai plateau, Anamalai hills

S. No.	Herd ID	Number	Age-sex classification	Tracked between	Days tracked
1	U1	8	3 AF, 1 SAM, 2 JUV, 2 CAL	16-Apr-02 to 21-May-02	36
2	S2	9 [b]	4 AF, 1 AM, 1 SAM, 1 SAF, 2 JUV	21-May-02 to 04-Jun-02	15
3	U2	11	6 AF, 1 AM, 2 JUV, 2 CAL	06-Jun-02 to 18-Jun-02	13
4	U3	9 [b]	5 AF, 1 SAM, 2 JUV, 1 CAL	16-Jul-02 to 17-Jul-02	2
5	C5 [a]	11	6 AF, 2 JUV, 3 CAL	12-Aug-02 to 22-Aug-02	11
6	S6	8 [b]	4 AF, 2 JUV, 2 CAL	20-Jul-02 to 29-Jul-02	10
7	K7	20	11 AF, 1 SAM, 1 SAF, 3 JUV, 4 CAL	05-Aug-02 to 19-Sep-02	45
8	A8	8	4 AF, 2 JUV, 2 CAL	02-Sep-02 to 04-Sep-02	3
9	M9[a]	9	4 AF, 1 AM, 1 SAM, 1 JUV, 2 CAL	09-Oct-02 to 03-Feb-03	68
10	N10 [a]	20	10 AF, 1 SAM, 1 SAF, 3 JUV, 5 CAL	10-Nov-02 to 03-Mar-03	58
11	G11	18 [b]	5 AF, 2 SAF, 2 JUV, 3 CAL, 6 UN	Located on 8/12/02	— [c]
12	S12	9 [b]	4 AF, 1 SAM, 1 SAF, 2 JUV, 1 CAL	Located on 11/11/02	— [c]
13	S13	7 [b]	1 AF, 1 SAM, 2 JUV, 3 CAL	26-Oct-02 to 28-Oct-02	3
14	T14	15	9 AF, 1 SAF, 1 JUV, 4 CAL	08-Dec-02 to 11-Dec-02	4
	Total	162			268

[a] These three herds appeared to be regular visitors to the Valparai plateau.
[b] Partial counts: a few individuals may have been missed in dense vegetation.
[c] These individuals joined with other herds being tracked.
AM = Adult Male; AF = Adult Female; SAM = Sub-adult Male; SAF = Sub-adult Female; JUV = Juvenile; CAL = Calf; UN = Unclassified

Appendix 2

Costs (in Indian rupees) to private companies, individuals, and the government for various categories of elephant-related damage on the Valparai plateau (April 2002 – March 2003). (Note: 1 USD = approx. Rs. 45)

A) Damage in different categories

Company/Individuals/ Government	Building damage	Raiding of provisions	Plants	Others	Total
Bombay Burmah Trading Corporation Ltd (BBTC)	56,255	1,200	23,710	12,400	93,565
Hindustan Lever Ltd (HLL)	195,756	8,460	950	500	205,666
Jayshree Tea Ltd	40,626		25,515		66,141
Parry Agro Industries Ltd	1,665				1,665
Peria Karamalai Tea Ltd	6,315			1,160	7,475
Tata Tea Ltd	10,256	11,000	600	14,500	36,356
Woodbriar Estates	11,880	2,200	550	190	14,820
Individuals	58,140	42,600	18,445		119,185
Government		113,244		100,000*	213,244
Total	**380,893**	**178,704**	**69,770**	**128,750**	**758,116**

* Compensation paid for one human death due to elephants.

B) Damage during peak conflict period (October – January)

Company/Individuals/ Government	Total loss (Rupees)	Loss during peak conflict (Oct – Jan) (Rupees)	(Percentage)
Bombay Burmah Trading Corporation Ltd (BBTC)	93,565	91,635	97.9
Hindustan Lever Ltd (HLL)	205,666	163,926	79.7
Jayshree Tea Ltd	66,141	65,041	98.3
Parry Agro Industries Ltd	1,665		0.0
Peria Karamalai Tea Ltd	7,475	230	3.1
Tata Tea Ltd	36,356	33,228	91.4
Woodbriar Estates	14,820	410	2.8
Individuals	119,185	113,035	94.8
Government	213,244*	91,379	42.9
Total	**758,116**	**558,884**	**76.8**

* Includes compensation amount for one human death due to elephants (24 May 2002)

Appendix 3

Records of human deaths due to elephants over a ten-year period on the Valparai plateau, Anamalai hills (1994 – 2003).

All deaths occurred within the 220 km² area of private plantations that fell within the Manamboli and Valparai ranges of the Indira Gandhi Wildlife Sanctuary. During this period, no human deaths due to elephants occurred within the portion of these two Ranges that fell within the 958 km² protected area.

S. No.	Date	Name of person (sex and age)	Occupation	Location
1	22/01/1994	Mariyammal (F 38)	Estate worker	Injipara
2	17/06/1994	Santhanamari Valliammal (F *)	Estate worker	Sirikundra
3	04/08/1994	Bhuvaneswari (F 13)	School student	Korangumudi
4	16/12/1994	Mathivanan (M *)	*	Anali
5	25/12/1994	Mani alias Mylvanan (M 35)	Wife is temporary worker	Uralikkal
6	16/12/1995	Kuppan (M 31)	Seasonal worker	Varattuparai
7	21/01/1996	Thavisikannu (M 65)	*	Tantea
8	11/04/1996	N. Sankili (M 55)	Contract worker	Pannimed
9	17/06/1996	Senthilkumar (M *)	*	Korangumudi
10	05/01/1997	Karuppayi (F 50)	Tribal	Thaymudi
11	26/01/1997	Anandan (M 40)	Supervisor	Korangumudi
12	28/01/1997	Palaniammal (F 50)	Estate worker	High forest
13	30/01/1998	Nataraj (M 55)	Estate worker	Karumalai
14	20/06/1998	Vijayakumar (M 23)	Casual worker	Tantea
15	29/01/1999	Yellammal (F *)	*	Tantea
16	23/02/1999	Sundaram (M 65)	Retired employee	Vellamalai
17	05/02/2000	Narayanaswamy (M 55)	Estate worker	Tantea
18	20/09/2000	Bomman (M 45)	Seasonal worker	Sriram
19	10/11/2000	Muthulakshmi (F 23)	Estate worker	Karumalai
20	19/12/2000	Chandran (M 41)	Milk supplier	Uralikkal
21	16/02/2001	Nalayya (M 55)	Estate worker	Uralikkal
22	20/02/2001	Kadirvelu (M 55)	Estate worker	High forest
23	05/01/2002	Devaraj (M 50)	Contract worker in Forest Dept; wife is permanent worker	Mudis
24	17/01/2002	Mariyappan (M 45)	Supplier to shop (wife is permanent worker)	Thaymudi
25	24/05/2002	K. V. Nataraj (M 45)	Temporary security guard	Injipara
26	15/04/2003	Appavu (M 65)	Noon-meal centre worker	Korangumudi
27	17/12/2003	Vaidyalingam (M 67)	Retired employee	Nadumalai

*Details not available.

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With financial support from

United States Fish and Wildlife Service

The Elephant Sanctuary, Tennessee

nature conservation foundation

science for conservation